

DUE NEWS 1996

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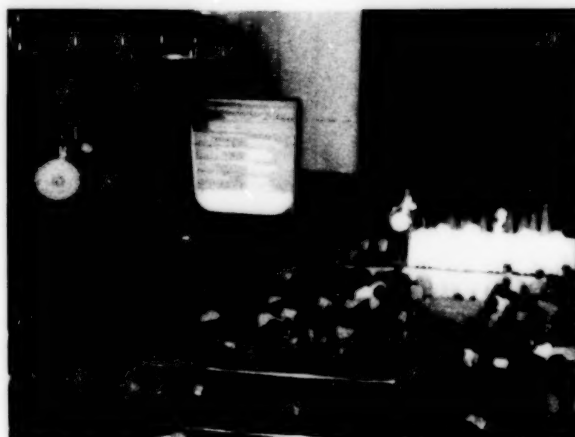
Reviewing the Nation's Undergraduate Education



During the past year, a subcommittee of advisors to NSF's Directorate for Education and Human Resources conducted a nationwide review of the status of undergraduate education in science, mathematics, engineering, and technology (SME&T).

This very broad review considered the needs of all students at all types of institutions serving undergraduates.

It considered numerous other studies and reports, conducted focus groups, and invited comments and ideas from a large number of stakeholders in undergraduate education, including: students, parents, educators, administrators, professional associations and societies, federal agencies, industry and other employers.



The National Research Council joined forces with NSF in conducting this review, designating academic year 1995-96 as a "Year of National Dialogue" on this subject.

The needs of undergraduates have been weighed in light of the opportunities for improved educational experiences and learning, in consideration of the rapid development of information technology and educational technology, and in response to the skills most frequently identified as critical by employers.

The review team paid particular attention to the needs of all undergraduates for broad competency and knowledge in SME&T, and on the needs of those preparing to be classroom teachers.

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A Message from the DUE Division Director

1996: A Truly Extraordinary Year

This has been an exceptionally dynamic and exciting year for NSF's Division of Undergraduate Education (DUE). The recent conference, *Shaping the Future: Strategies for Revitalizing Undergraduate Education* held in Washington, DC, July 11-13, was in many ways a fitting capstone for the Division's activities during FY 1996. The principal focus of the conference was the **Review of**

Undergraduate Education (see story above), a year-long study of the state of U.S. undergraduate education in science, mathematics, engineering, and technology (SME&T). As the outcome of a comprehensive process of public hearings, interviews, discussions, and a synopsis of hundreds of opinions solicited from across the nation, the forthcoming report about the review will mark the first major study of its kind in nearly a

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Who's Who at DUE:

Permanent staff are listed by name only; others are on leave from the institutions noted in italics.

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(for the year beginning 11/96)

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Duncan E. McBride

Social and Behavioral Sciences

Myles G. Boylan

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Reviewing the Nation's Undergraduate Education

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A clear picture has emerged from this review of 1) major opportunities to improve the quality of undergraduate SME&T instruction (resulting from numerous innovative developments), 2) rapidly growing needs to make these improvements on a number of fronts (perhaps most urgently for the preparation of classroom teachers), and 3) an academic climate that is increasingly receptive to comprehensive and systemic efforts to improve education.

Effective methods of instruction entail emphasis of active, participative, and frequently collaborative techniques that engage students in important problems and issues and provide them the opportunity to learn these subjects by direct experience with the methods and processes of inquiry.

Systemic reform will need to occur on a number of fronts in order to increase substantially the effectiveness of instruction in undergraduate SME&T education. Areas in need of change include a faculty reward system that too often recognizes only research successes, an academic organizational structure that reflects high faculty autonomy rather than departmental responsibility for student outcomes, and a departmental structure that is typically designed to meet the requirements of research specialization rather than the needs of undergraduate students. It will also be necessary to invest more in the development of faculty instructional skills.

The impact of systemic reform is increased by successful collaboration of faculty from different SME&T departments (including the school of education, as appropriate), growing partnerships among institutions, as well as strengthened connections between colleges and employers.

— Myles Boylan

New Initiative Invites Institution-Wide Reform

The National Science Foundation's Directorate for Education and Human Resources (EHR) successfully launched a new initiative in the 1996 Fiscal Year: *Institution-Wide Reform of Undergraduate Education in Science, Mathematics, Engineering, and Technology (SME&T)*. Funding provided through the "IR" initiative is both an incentive and a recognition of those institutions that are making significant gains in the quality of their undergraduate education programs and are now prepared to introduce reforms that combine and transcend traditional academic disciplines and impact all students.

The NSF Institution-Wide Reform Initiative

Announced: August, 1995

Aim: To promote the development of comprehensive and self-sustaining reform efforts in undergraduate education.

Eligibility: All institutions that teach undergraduates.

Amount: Up to \$200,000 each.

Duration: Specific to project.

Process: Successful proposals offer visionary plans for institution-wide reform of undergraduate education based on significant achievements, with the intent of providing national models of excellence.

Recent criticisms of higher education have included such issues as: substandard instruction of courses by graduate students, professors who are "preoccupied by research," curricula that are outmoded and unsuited to the needs of students entering the workforce, and outdated systems for instructional delivery (e.g., large lecture-style classes and insufficient or ineffective use of technology). However, universities and colleges are working hard to dispel these perceptions and, in some cases, realities.

By supporting projects from comprehensive and research universities, community colleges and liberal arts colleges that present visionary plans for revitalizing undergraduate education, the IR awards intend to stimulate changes in

the institutional culture and structure and to produce national models of excellence in SME&T education that will impact all students.

A major objective is to help two- and four-year colleges and universities align their curricula with the employment opportunities that await their students as graduates. For FY 96, NSF received more than 130 proposals and made awards of up to \$200,000 each to the 23 institutions listed alphabetically below:

- California Institute of Technology (CA)
- California State University - Fullerton (CA)
 - Clark Atlanta University (GA)
- Community College of Philadelphia (PA)
 - Grinnell College (IA)
 - Miami University (OH)
- Middlesex County College (NJ)
 - New York University (NY)
 - Northeastern University (MA)
- Oakton Community College (IL)
 - Panola College (TX)
- Rensselaer Polytechnic Institute (NY)
- The Richard Stockton College of New Jersey (NJ)
 - Salish Kootenai College (MT)
- St. Andrews Presbyterian College (NC)
 - Stanford University (CA)
- State University of New York - Binghamton (NY)
 - University of California - Berkeley (CA)
 - University of Hartford (CT)
- University of Michigan - Ann Arbor (MI)
- University of Michigan - Dearborn (MI)
 - University of Rochester (NY)
- Wake Technical Community College (NC)

The initial response to NSF's *Institution-Wide Reform* initiative is encouraging and suggests a strong inclination within academe to initiate changes. These inaugural awards have the potential to serve as national exemplars, leading the way in meeting the needs of their own students while providing models for the Nation's higher education system, now and for the decades to come.

— Herb Levitan

Shaping the Future: A National Working Conference

In July, NSF in cooperation with the **National Research Council (NRC)**, sponsored the national working conference, *Shaping the Future: Strategies for Revitalizing Undergraduate Education* (held July 11-13, 1996, at the Sheraton Washington Hotel, Washington, DC).



Shaping the Future



The intent of the conference was twofold:

Firstly, to provide a forum for discussion and analysis of two recently completed studies of U.S. higher education: The **Review of Undergraduate Education** and the NRC's Report of a Convocation, "From Analysis to Action." The "Year of National Dialogue" was NRC's follow-up to the Convocation, a conference sponsored jointly by NSF and NRC that kicked-off both reviews. The chairpersons for these activities, **Melvin George** (for NSF) and **Donald Kennedy** (for NRC), were on hand at *Shaping the Future*, and discussed their findings at an informal "fireside chat" plenary session, which was cited as a conference highlight by many participants.

Secondly, *Shaping the Future* recognized new partnerships and strategic plans proposed for the systemic reform of undergraduate education, including the awardees for the first year of NSF's **Institution-wide Reform initiative** (see page 3) and recent signatories to the **Memorandum of Understanding** for the revitalization of undergraduate education deriving from April's **Foundation Roundtable** discussion (see page 14).

Included in the rigorous agenda were several roundtable discussions featuring representatives from industry (moderated by **Denice Denton**, Dean of Engineering Designate, University of Washington), legislators (held at the National Academy of Sciences and moderated by **Alfredo de los Santos Jr.**, Vice Chancellor of the Maricopa Community Colleges, AZ), and academic presidents (moderated by NSF Assistant Director for Education and Human Resources **Luther Williams**). **Bill Kurtis**, Chicago news anchor and producer of *The New Explorers*, gave an engaging presentation on the role of video in capturing and inspiring the interest of students in learning about science.



Conference delegates browse the exhibitors' hall, featuring approximately 50 institutional teams, as well as publishers, employers, and other representatives from industry.

A number of smaller-sized breakout sessions were also held, including "birds of a feather" discussion groups that encouraged exchanges between and among representatives from industry, institution presidents, faculty, and students. Teams of participants from 50 invited institutions provided representatives from all levels of the undergraduate experience, including students, faculty, presidents, alumni and representatives from industry. These teams also exhibited completed examples of products and pedagogical techniques in the systemic revitalization of higher education, as well as the plans for similar gains proposed by recent awardees. Also featured were displays from publishers and industry.

Over the three-day event, the 550 participants also heard views from state representatives **Andrew Nichols** (AZ) and **Mignon Waterman** (MT), and **David Goldston** (representing Congressman **Sherwood Boehlert**, NY) on how academe can better communicate their needs and concerns to legislators; from **Clarence Eidt, Jr.** (Exxon), **Jimmie Haines** (The Boeing Company), **Alfred Moyé** (Hewlett-Packard), **Pamela Peters** (Genentech), and **John Saurer** (Eastman Kodak) on industry's views of undergraduate education; and from NSF Director **Neal Lane** and National Academy of Sciences President **Bruce Alberts** on how their respective agencies can coordinate and support cooperatively successful reform efforts.

Shaping the Future was highly successful in providing a dynamic forum for various stakeholders in quality undergraduate education to discuss the "state of the nation" on several key issues. NSF, in cooperation with the NRC, industry partners, and all institutions offering undergraduate education, is now poised to use these tangible first steps as a springboard for implementing many of



The Great Hall at the National Academy of Sciences provided an elegant setting for the July 12 plenary session and Legislators Roundtable.

the strategies proposed, and to assist successful models as they look towards adaptation, dissemination, and other next steps. A volume of conference proceedings will be issued in the coming months. Look for future editions of *DUE News* to carry updates on the growth and progress of these exciting strategies for revitalizing undergraduate education.

— Janet Rutledge

Shaping the Future Summary of the Conference Agenda

Thursday, July 11

- Welcoming Reception and Exhibits
- Plenary Session I
"The Challenge to U.S. Undergraduate Education"
Welcoming Address - Luther Williams
Industry Roundtable - Moderator: Denise Denton
- Focus on Exhibits

Friday, July 12

- Plenary Session II
"Perspectives on Revitalizing Undergraduate Education"
Keynote Address: Neal Lane
- Plenary Session III
"The NSF Review of Undergraduate Education and the NRC
'Year of Dialogue'."
Hosted by: Melvin George, Donald Kennedy

Friday, July 12 (cont'd)

- Breakout Sessions I & II
- Academic Presidents/Provosts Forum
- Plenary Session IV
(at the National Academy of Sciences)
Speakers: Bruce Alberts, Clarence Eidt, Jr.
- Legislators Roundtable
Moderator: Alfredo de los Santos, Jr.
- Evening Reception at the National Air & Space Museum

Saturday, July 13

- Corporate and Foundation Partners Forum
- Breakout Sessions III & IV
- Academic Presidents/Provosts Forum
- Luncheon
Keynote Speaker: Bill Kurtis
- Plenary Session V
"New Directions for Undergraduate SME&T Education"
Academic Presidents Roundtable - Moderator: Luther Williams

New Collaboratives Support Urban Teacher Preparation

NSF is undertaking a major effort to improve significantly the science, mathematics, engineering, and technology (SME&T) education of prospective elementary and secondary teachers. The SME&T that prospective teachers learn as part of their undergraduate education and the manner in which the courses are presented, have a critical influence on the quality of their teaching. Knowledgeable teachers who are excited about the subjects they teach will ensure that their students are well prepared in SME&T subjects.

The NSF Collaboratives for Excellence in Teacher Preparation (CETP) program is one major programmatic thrust of DUE. It supports large-scale systemic projects designed to significantly change teacher preparation programs on a state or regional basis and to serve as comprehensive national models.

In addition to the Collaboratives program, DUE supports projects with a concentration or focus on teacher preparation in each of its other programs: Advanced Technological Education (ATE), Course and Curriculum Development (CCD), Instrumentation and Laboratory Improvement (ILI), and Undergraduate Faculty Enhancement (UFE).

Three collaboratives were newly funded in FY 96, involving a total of 20 institutions, including two-year, four-year, comprehensive and research institutions. The **San Francisco Bay Area Collaborative for Excellence in Teacher Preparation** (including San Jose State University, San Francisco State University, the College of San Mateo, San Jose City College, Evergreen Valley College, and City College of San Francisco) serves a large urban area; the collaborative, **Recruitment,**

Training, and Retention of Oklahoma Science and Mathematics Teachers (including the University of Tulsa, Oklahoma State University, the University of Oklahoma, the University of Central Oklahoma, Northeastern State University, Southwestern Oklahoma State University, Cameron University, and Langston University) includes a similarly broad set of institutions; and the **Virginia Urban Corridor Teacher Preparation Collaborative** (including Virginia Commonwealth University, Longwood College, Mary Washington College, Norfolk State College, and Germana, J. Sargeant Reynolds, and Tidewater Community Colleges) also serves a broad urban area. These projects feature the participation of groups and settings not previously intimately involved with teacher preparation in SME&T.

Student groups targeted include such unique populations as those preparing to be teachers aides (para-teachers). Participants in efforts to incorporate creative methods of teaching in SME&T course reform include, as crucial components, master K-12 teachers, actively involved as equal partners both in course and program development and in faculty enhancement.



Institutions involved in project activities include such informal but rich settings as museums, research laboratories, and zoological parks.

Activities include: summer academies to engage all stakeholders, including students, in course design, implementation and assessment; integrated capstone courses designed by faculty from multiple disciplines; and systems to identify and support a cohort of students preparing to be teachers from their freshman experience through their first three years of teaching.

NSF efforts in teacher preparation respond to the nation's need for well-trained SME&T educators. A study recently released by the Council of Great City Schools reveals that over 60% of the school systems in the nation's largest cities have an immediate demand for mathematics or science teachers. These three collaboratives will join the 10 collaboratives first funded in FY 93 through FY 95 (*see sidebar*). Collectively incorporating more than 110 institutions, the CETP program expects to continue to fund three to five projects each year at a level of \$500,000 to \$1,000,000 per year for up to five years.

Each CETP project represents a set of unique needs, resources, participating institutions, population, geography, and cultural and political traditions. Six of the continuing projects are urban centered (Arizona State University, California State University at Dominguez Hills, City University of New York, Harvard University, Temple University, and the University of Texas at El Paso); three projects encompass institutions distributed throughout the state (Louisiana, Maryland, and Montana); while the collaborative project from Northern Colorado is regional in character.

All CETP projects include strong leadership and participation from faculty in SME&T departments working in partnership with faculty from the departments of education and master K-12 teachers. Since attention to introductory courses is essential, each project must include strong leadership by the faculty and departments responsible for such courses.

CETP Full Collaboratives FY 93 to FY 96

- Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT). *Arizona State University (DUE-9453610).*
- Los Angeles Collaborative for Teacher Excellence (LACTE). *California State University, Dominguez Hills (DUE-9453608).*
- San Francisco Bay Collaborative for Excellence in Teacher Preparation. *San Jose State University (DUE-9553786).*
- Rocky Mountain Teacher Education Collaborative (RMTEC). *University of Northern Colorado (DUE-9354033).*
- Louisiana Collaborative for Excellence in the Preparation of Teachers (LaCEPT). *Louisiana Board of Regents (DUE-9255761).*
- Maryland Collaborative Excellence in Teacher Preparation (MCTP). *University of Maryland (DUE-9255745).*
- Teacher Education Addressing Mathematics and Science in Boston and Cambridge (TEAMS-BC). *Harvard University (DUE-9354052).*
- Systemic Teacher Excellence Preparation: The STEP Project. *Montana State University (DUE-9255792).*
- New York Collaborative for Excellence in Teacher Preparation. *City University of New York, Brooklyn (DUE-9453606).*
- Recruitment, Training and Retention of Oklahoma Science and Mathematics Teachers. *University of Tulsa (DUE-9553790).*
- Collaboratives for a New Model for K-12 Teacher Preparation Focused on Enhancing Math/Science Knowledge, New Methodologies and Technology. *Temple University (DUE-9354034).*
- The El Paso Partnership for Excellence in Teacher Preparation (PETE). *University of Texas, El Paso (DUE-9453612).*
- Virginia Urban Corridor Teacher Preparation Collaborative. *Virginia Commonwealth University (DUE-9553789).*

Listed alphabetically by state

Over the past four years, NSF has awarded \$63 million dollars through the CETP program. Last year alone, these projects involved over 20,000 students in classes designed to help students develop their skills as SME&T teachers. "These awards will enable the training of a generation of teachers who are knowledgeable in their content areas, creative, enthusiastic and life long learners," said **Luther Williams**, NSF's Assistant Director for Education and Human Resources.

In addition, FY 96 CETP development grants of approximately \$100,000 each were given to the University of Alabama at Birmingham, the University of Hawaii, and the University of Delaware.

— **Terry Woodin**

**AN EXTRAORDINARY
YEAR** *(continued from page 1)*

decade. The report is currently available on DUE's home page on the World Wide Web and will also be widely distributed in print form (request document NSF 96-139). The report has great potential to catalyze discussion and needed change in undergraduate education, and we invite suggestions for assistance and participation in implementing its recommendations locally as well as nationally.

Shaping the Future also celebrated the inaugural awards for the initiative, *Institution-wide Reform of Undergraduate Education in SME&T* (see page 3). The "IR" program is managed by DUE in collaboration with the other Education and Human Resources (EHR) divisions. Represented among the 23 awards were research universities, community colleges, comprehensive universities and liberal arts colleges. We expect these institutions will demonstrate visibly to the public, government and state legislators, and Boards of Trustees, that higher education is committed to serving the best interests of its students and society.

Increasingly, quality undergraduate SME&T education is necessary for the success of most citizens in our complex civilization. Consistent with the findings of the Review, DUE continues to regard as its

goal the best possible undergraduate SME&T education for all students in all types of U.S. two- and four-year colleges and universities, and maintains a portfolio of programs to promote this ambitious agenda.

However, if one were to ask what issue deserves DUE's most urgent attention, the answer would be to foster improvement in the preparation of the Nation's future elementary and secondary school teachers of science and mathematics. We believe that SME&T faculty, working in collaboration with their colleagues in colleges of education, are key to the success of teacher preparation programs.

A second major DUE priority is the health of science and technology education in U.S. community colleges, especially as it relates to the preparation of students to enter the industrial, technical workforce. In both of these important areas collaboration among two- and four-year colleges and universities, the schools, and industry is often essential if improvement efforts are to succeed.

One of the advances in recent years in undergraduate education is the accumulation of a growing knowledge base on what works in the teaching and learning process. Much of this knowledge has been incorporated in undergraduate

curriculum and laboratory projects sited at many colleges and universities across the country, and some excellent, creative examples of DUE-supported projects are described in this publication.

The extensive activity and change occurring in undergraduate education has fostered an increased need and opportunity to make this information more readily available to the widest possible audience. DUE is therefore in the process of gathering information to determine what role it should take in encouraging and assuring the systematic dissemination of peer reviewed findings, products, and outcomes of research and development projects related to undergraduate SME&T education.

These are times of uncertainty for many people, but they are also times of great promise as we see increasing interest in, attention to, and improvements of undergraduate SME&T despite increasing complexity of mission and demands on faculty and institutions.

We at DUE want to be as effective as we can be to assist in the process of needed change in undergraduate education. As always, we would welcome comment and advice on the contents of this, DUE's fourth annual newsletter, and on any aspect of the DUE mission.

— **Robert F. Watson**
*Director,
NSF Division of
Undergraduate Education*



Community Impact

Articles By and About DUE Principal Investigators and their Projects

Harvard Professor Adopts Peer Instruction to Promote Renewed Interest in Science and Engineering Courses

With funding assistance from DUE's **Course and Curriculum Development (CCD) program**, a revolutionary pedagogical technique is impacting introductory science students at Harvard University. **Eric Mazur**, Presidential Young Investigator and Harvard's Gordon McKay Professor of Applied Physics, is the principal investigator of the project, "Peer Instruction: Stimulating Renewed Interest in Physics and Other Science and Engineering Courses," which has received CCD funding since FY 93.

The project addresses the widespread problem of student dissatisfaction with traditional introductory science courses. Mazur, a respected researcher in optical physics, believes that too much lecture time is usually spent on problem-solving skills, not explaining fundamental concepts. The result is rote memorization of problem solving techniques and passive student reception of lecture material without a proper appreciation of the fundamental scientific concepts involved.

Mazur's method uses "ConcepTests" and peer interaction to expose students' misconceptions about syllabus topics, then to rectify these notions with enhanced conceptual understanding. Using Peer Instruction techniques, about one-third of lecture time is devoted to the asking of conceptual questions with multiple-choice answers. Student responses, misconceptions, and levels of confidence in their answers are immediately recorded using classroom computer technology. Students are then asked to discuss their answers with classmates and, if necessary, revise their answers and levels of confidence in them. Finally, clarification of the concept is provided by the instructor, guided by the original class responses and subsequent reconsideration.



Using peer instruction, students test each other's knowledge of the concepts underlying the scientific process. The method enhances the students' understanding of the material as well as their ability to explain it to others.

Mazur's peer instruction method was first used successfully in large, introductory calculus-based physics classes. The initial impact on student performance was so encouraging that the technique has now been applied across disciplinary boundaries and at other institutions. Professor **Albert Altman**, a collaborator on the method, now uses Peer Instruction for an introductory engineering course at the University of Massachusetts-Lowell. **C. Bradley Moore**, a chemist at the University of California-Berkeley, is among several other instructors who have also successfully used the technique. Mazur's text, "Peer Instruction: A User's Manual" is being published by **Prentice-Hall**.

Although statistics on the project's success are still being compiled, the use of ConcepTests and student interaction have improved student performance on conceptual questions, as well as in solving problems based upon them. The ultimate benefits of peer instruction are improved understanding and appreciation of material and increased student interest in science courses that can be applied across many disciplines.

Community Impact

DUE and Mathematics in Puerto Rico

Contributed by:

Rafael Martinez-Planell

A few years ago, we were reading of the changes occurring throughout the mainland United States in the teaching of mathematics. Some of these changes were due to an increased use of technology in the classroom. Related but more fundamental changes were resulting from the rethinking of the curriculum that came along with the **Calculus Reform** movement. We asked ourselves how these changes could be integrated with our program at the University of Puerto Rico Mayaguez. We started by sending two of our professors to participate in a workshop sponsored by the **Undergraduate Faculty Enhancement (UFE) program** at the City University of New York, Manhattan.

Upon returning, we taught a few pilot pre-calculus sections using the graphing calculator. The results were so gratifying that we decided to implement these changes in all our pre-calculus sections, provided the professors teaching the courses could be convinced to adopt the change.

A considerable portion of our pre-calculus sections is taught by tenured professors with terminal Masters degrees who teach up to 18 credit hours per semester. Most of them were unaware of the newer issues associated with teaching reform and the use of technology in the classroom, and were hesitant to change what they had been doing for so many years. The same could be said of faculty at neighboring two-year colleges, who must be considered since many of their students transfer to our university. Any changes in our basic curriculum directly affect the course equivalents at these contributory institutions.

Next, we personally contacted the mathematics department chairpersons at a variety of the institutions involved and showed them a prospectus for a joint faculty enhancement project.



Betty Ramirez and Rafael Martinez-Planell.

The proposal, "Using Technology to Enhance the Teaching of Calculus and Precalculus," was written with the collaboration of nine colleges and approved by the National Science Foundation's UFE program. The project enabled us to offer workshops on graphing calculators, University of Arizona software, collaborative learning techniques, projects for student investigation and other classroom activities, materials from the **Calculus Consortium** based at Harvard (CCH), *Derive* and *Mathematica*.

We also organized a three-day conference - the first of its kind in Puerto Rico - dedicated entirely to the use of technology and reform in the teaching of calculus and pre-calculus. This meeting was co-sponsored by the NSF-supported Alliance for Minority Participation project of Puerto Rico.

All this activity has resulted in a faculty that is aware and willing to accept the challenge of change. The original project approved by the Undergraduate Faculty Enhancement (UFE) program has proven itself pivotal in promoting the intended curricular changes as well as in spurring a series of related projects and activities. It forged bonds between the participating institutions that have spurred collaboration in other projects.

Somewhat unexpectedly, it also produced a surge of precollege-oriented activities and externally funded projects as several of the participating professors began exploring the use of technology in middle school and high school mathematics.

Community Impact

The Geographer's Craft Project at the University of Texas at Austin



Contributed by:
Kenneth E. Foote

Begun as a laboratory improvement project in 1992, "The Geographer's Craft" has developed into one of the very first courses to be issued entirely in hypertext on the World Wide Web. So rapidly has the project progressed that the materials are now being used by geography departments at over 30 other universities and by a wide range of businesses and government agencies. In addition, the materials are now serving as a model for the creation of additional online courses at the University of Texas and at many other universities. Two NSF grants have supported the project and demonstrate how money invested in education can yield substantial dividends both locally and nationally.

The first grant, from DUE's **Instrumentation and Laboratory Improvement (ILI) program** was for computer equipment to develop a new two-semester, year-long course in research techniques for geography majors. The goal of the course was to promote analytical reasoning and critical thinking skills among students by having them address real-world research questions relating to environmental management and resource analysis.

In the process of answering these questions, the students were taught how to apply a range of techniques drawn from cartography, geographic information systems, remote sensing, and spatial statistics. By adopting an approach based on problem-solving rather than exercises, students gain a better sense of how to integrate techniques and better address the sorts of challenges they will face in professional life.

Use of the World Wide Web allowed "Geographers Craft" materials to be linked through the Internet to research and study materials available anywhere in the world. The success of these experiments with networked, hypertext teaching materials during 1992 led to a subsequent proposal funded by the **Course and Curriculum Development (CCD) program** to provide staff support to develop additional online hypermedia materials, far more than were envisioned in the first grant. Indeed, by the end of the CCD grant, the "Geographer's Craft" project will have published the first complete online, hypermedia text in geography. At the same time, we are working on Web versions of upper-level classes in geographic information systems and a seminar on the history and philosophy of geography. All of these materials can be accessed at the URL:

<http://www.utexas.edu/depts/grg/main.html>

During 1994-95, it became apparent that "Geographer's Craft" materials were beginning to be used in other departments and serving as a model for the development of online courses at other universities. Interest was so high that work began on building a "Virtual Department" linking geography curricula nationally and internationally using the Internet. The "Geography Virtual Department" project on the World Wide Web is an outgrowth of "The Geographer's Craft" that links curriculum and research materials being developed by geography departments worldwide. Thirteen geography courses are now online, and geographers can begin to work toward common goals and share the time and expense of developing the sorts of networked, hypermedia curriculum materials that are likely to become the hallmark of higher education and the "virtual universities" of the 21st century.

Check out *The Geographer's Craft*
and other DUE project WWW sites at:
<http://www.ehr.nsf.gov/EHR/DUE/start.htm>



Meetings and Workshops

A Review of Past and Upcoming DUE-Supported Events

Workshop Discusses National Center for Educational Resources

A workshop on a National Library (NL) for undergraduate science education was held at NSF on April 18, 1996. Hosted on the same day at NSF as the **Foundations Roundtable** meeting (see page 14) and the first day of the **Information Technology workshop** (see page 13), there was some overlap in participants in order to bring together and synergize common themes in undergraduate education.

The NL workshop participants provided advice on the design and implementation of a national service for the collection and dissemination of educational resources. The following comments and recommendations were made concerning the form and function of the proposed service:

- There is an overwhelming need for a service that will capture "home grown" materials, which have not been widely disseminated, as well as materials already published; develop protocols for selection, verification, and validation of materials; make connections throughout the system via indexing and linkage functions; and provide a moderated, interactive, public forum on educational issues.
- It was the opinion of workshop participants that the existing services do not effectively meet the needs of the undergraduate science education community, although many of these services may serve as valuable adjuncts to such a library.
- This service must include editorial functions to provide the highest level of confidence in the quality of the materials. As an archive, this would be a primary source of useful materials that can be easily accessed.
- The service must also be dynamic, with the ability to review materials through continuing comment and reply, and it must be flexible, to accommodate the changing needs and opportunities of faculty, new materials, and new technologies.

- There are major differences in the nature of textual materials vs. other types of learning materials (e.g. software, information technology, etc.), and the review process must be able to accommodate a wide variety of materials.
- Procedures must be established to encourage faculty to submit new materials to the NL.
- Effective delivery systems must also be developed to ensure that faculty can readily access and use these materials in new and meaningful ways.
- Materials that are accepted into the library will have value added through validation in the editorial process and through greater dissemination throughout the scientific community.
- Faculty must find that the services provided by the library are worthwhile, in terms of ease of access to, and confidence in the quality of the materials within.
- This service should operate, be coordinated and maintained out of an easily recognizable place. Essential staff should include an editorial board with credibility in the SME&T disciplines, marketing, management, and information technology.

Furthermore, participants acknowledged the value the proposed library would generate. Its national stature would serve as an incentive for faculty to develop and promote new educational materials and methods and to persuade faculty to access and use the library's resources. Such an incentive would play an integral role in promoting and sustaining comprehensive reform of the undergraduate enterprise.

— Hal Richtol

Information Technology and National SME&T Education: Challenges and Opportunities

To help provide guidance to the National Science Foundation and DUE on the use of information technology and the possibilities it holds for enabling improvements in undergraduate education, a meeting was convened by DUE on April 18-20, 1996, entitled *Information Technology: A Workshop on its Impact on Teaching and Learning in Undergraduate Science, Mathematics, Engineering, and Technology Education*.

This meeting brought together in a working conference approximately 35 participants representing a cross-section of the broader undergraduate educational community, including faculty, students, administrators, publishers, and representatives of industry.

The primary purposes of the workshop were:

1. To identify examples of the "effective" uses of information technology;
2. To consider their impact on various parts of the undergraduate enterprise (e.g., learning environments, pedagogical approaches/faculty development, administrative issues, human capital, infrastructure);
3. To investigate dissemination and assessment/evaluation issues implied by the use of information technology; and
4. To speculate on and help NSF anticipate the impact of future developments in information technology.

Prior to the meeting a listserv was used to generate e-mail discussion among participants in order to help attendees find a common ground in terms of their vocabulary and experience in discussing information technology, and to identify important themes and issues. The meeting itself was organized around a series of concurrent small group discussions.

Based on reports from the breakout sessions, themes for further in-depth discussion were

identified by the participants, who then reconvened to consider the following themes:

1. Faculty development for information technology usage;
2. Defining outcomes of information technology usage: measurement, assessment, and standards;
3. Sustaining communities of information technology developers and users;
4. Non-standard paradigms in teaching and learning fostered by information technology; and
5. Dissemination of insights about teaching and learning, enhanced by information technology, including new tools and methodologies.

During the last breakout session participants focused their attention on future directions and recommendations, with a goal of developing a set of "needs of the undergraduate community" in the use of information technology.

Post-workshop discussion has continued via the listserv and we expect that these contributions will be synthesized and included in a final workshop report.

— Lee Zia &
Michael Mulder



The Information Technology workshop discussed the potential and effective uses of technology in the classroom and its impact on the undergraduate enterprise.

Foundation Roundtable Commits to Improved Undergraduate Education

The NSF Foundation Roundtable, convened April 18, 1996, attracted representatives from DuPont, the Exxon Education Foundation, the General Electric Foundation, the Hewlett-Packard Company, the Howard Hughes Medical Institute, the MacArthur Foundation, the Pew Science Program, Shell Oil Foundation, and the Shodor Education Foundation.

In addressing the implications of various foundations/companies funding similar projects in laboratory improvement and curriculum and faculty development, the goals of the Roundtable were threefold:

- to share NSF's goals in undergraduate education with foundation representatives;
- to explore common goals in the outcomes expected from quality undergraduate education; and
- to explore next steps, including sharing information and the possibility of collaborative funding ventures.

The participants summarized their respective positions and presented an overview of recent activities; NSF Assistant Director for Education and Human Resources **Luther Williams** then summarized some of the collective challenges, including:

- K-16 education;
- teacher preparation;
- the impact of information technology;
- need for advocacy role of foundations and industry in revitalizing undergraduate education; and
- the need for continuing roundtable discussions.

Included in the ideas proposed was the development of a common set of metrics for evaluating and assessing funded projects, sharing of Web site information and encouraging electronic dissemination of information, and continued exploration of collaborative funding opportunities.

Following the meeting, a **Memorandum of Understanding** pledging to pursue a continued partnership in this direction was drafted. The group will continue to meet about twice a year, with all participants working to expand the circle of cooperation. Sharing of information on funded projects and exploration of ways to leverage support is already occurring.

A follow-up meeting to the Roundtable was held at the recent **Shaping the Future** conference. The Memorandum of Understanding was presented to the Corporate and Foundation Partners at a recognition ceremony at the **National Air & Space Museum**, wherein Dr. Williams reiterated NSF's commitment to forging further partnerships with industry and foundation partners, and encouraged others to contribute their endorsement to the document:

MEMORANDUM OF UNDERSTANDING For the Revitalization of Undergraduate Education July 12, 1996

In these rapidly changing times, the demands placed on the educational infrastructure of the nation, at all levels, are enormous and growing. This pace of change will continue to encourage cooperative relationships between all of those involved in, and all those who provide support for, the undergraduate education enterprise in the nation.

We, the undersigned, are committed to nurturing the evolution of the highest quality undergraduate science, mathematics, engineering and technology (SME&T) education, and to catalyzing working relationships between all parties involved in its delivery, and its support. Towards this goal we intend to cooperate with our colleagues in other private, government or industry oriented funding organizations that support under-graduate education in the nation. We intend to share information about our funding plans and funding profiles, to work towards common and complete assessment of our funded projects, to encourage the widest possible dissemination of project results, and, when appropriate, to support these projects through cost sharing partnerships. We intend to meet as a group periodically to share successes and to cooperate in developing national strategies in education. Through cooperation, we intend to amplify the impact of our individual efforts.

• The Boeing Company • DuPont • Exxon Education Foundation • Hewlett-Packard • Howard Hughes Medical Institute • Lucent Technologies • Pew Science Program • Shodor Education Foundation

— **Janet Rutledge
& Michael Mulder**

Fred Haise Keynotes NSF's Second Annual Community College Day

"Community colleges, rooted in their communities, are uniquely positioned to make sure all people gain access to the advantages of the information age."

— **Daniel Moriarty**
President,
Portland Community College (OR)
Chair, AACC Board of Directors

Celebrating community colleges and their role in science, mathematics, engineering, and technology education, April 1, 1996, was the date of NSF's second annual Community College Day. The event also appropriately "launched" Community College Month.

In his introductory remarks, **David Pierce**, President of the **American Association of Community Colleges (AACC)**, lauded the continued endorsement by NSF of the nation's community colleges. Under the directorship of EHR Assistant Director **Luther Williams** for the past five years, the budget for the Directorate for Education and Human Resources has nearly quadrupled. Support for community colleges has increased in recent years from about \$1 million to over \$35 million.

Last year, NSF held its first ever Community College Day, with **Gwendolyn Stephenson**, Chancellor of the St. Louis Community College System as the keynote speaker for the event. Drs. Pierce and Stephenson also testified on behalf of community colleges during the "Institutional Perspectives" hearing in support of the **Review of Undergraduate Education** (see page 1), convened October 25, 1995.



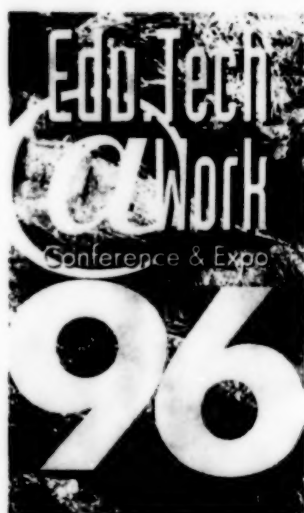
Astronaut Fred Haise was the keynote speaker at NSF's second annual Community College Day.

Fred Haise, Apollo 13 astronaut and retired president of **Northrop Grumman Technical Services**, was the featured guest speaker for NSF's second annual Community College Day. A graduate of Perkinson Junior College (now Mississippi Gulf Coast Community College), Haise received one of the AACC's Outstanding Alumni Awards for 1996.

Haise's presentation focused on his experiences aboard the Apollo 13 Mission. He also showed clips from the movie *Apollo 13* directed by **Ron Howard** as well as the actual footage the astronauts shot during the mission. Haise said that the story of how the astronauts and NASA's mission control worked together to guide the crippled spacecraft back to Earth safely "is probably the historical example of teamwork."

— **Peggie Weeks**

Edu.Tech@Work Prepares Knowledge Workers of the Future



Edu.Tech@Work 96, a national conference on preparing the "knowledge worker" of the future was held in Seattle May 2-3, 1996, and coincided with the official groundbreaking of the DUE-sponsored **NorthWest Center for Emerging Technologies (NWCET)**. Bellevue Community College President **Jean Floten** and NWCET Executive Director **Neil Evans** were also on hand at the conference to provide welcoming addresses to an impressive line-up of keynote speakers from leaders in technology, including **Bill Gates**, Chairman and CEO of **Microsoft**, **Philip Condit**, President of **The Boeing Company**, **Rob Glaser** of **Progressive Networks**, **Alan Chute** of **Lucent Technologies**, and **Deborah Triant** of **CheckPoint Software Technologies**.

Plenary topics ranged from the use of the Internet as a mass medium – and its use as a tool for educators as well as students – to what skills, habits, and career preparation will be in highest demand and of most use to the next generation of information and technology employees.

Regionally, the NWCET plans to figure prominently in the training of technical professionals as one of eight Centers of Excellence that have received funding from DUE's **Advanced Technological Education (ATE)** program over the past three years.

Concurrent sessions for the conference addressed such themes as *Education on the Information Superhighway*, *Multimedia Development and Distribution*, *The Internet as a Mass Medium*, and *People and Organizations for the 21st Century*.

— *Elizabeth Teles*

ATE Centers of Excellence FY 94 to FY 96

- Maricopa Advanced Technology Center (MATE) Phoenix, AZ (DUE-9602373)
- Advanced Technology Environmental Education Center (ATEEC) Bettendorf, IA (DUE-9454638)
- New Jersey Center for Advanced Technological Education Edison, NJ (DUE-9553749)
- National Center of Excellence for Advanced Manufacturing Education (NCE/AME) Dayton, OH (DUE-9454571)
- Northwest Center for Sustainable Resources (A National Center for Advanced Technology) Salem, OR (DUE-9553760)
- South Carolina Advanced Technological Education Center Columbia, SC (DUE-9602440)
- Southwest Regional Center for Advanced Technological Education Sweetwater, TX (DUE 9454551)
- NorthWest Center for Emerging Technologies: New Designs for Advanced Information Technology Education Bellevue, WA (DUE-9553727)

Listed alphabetically by state

Meetings and Workshops

Reexamining the Role of SME&T Faculty, Departments in Teacher Preparation

Deans and Chief State School Officers are reexamining the role of science and mathematics departments in the preparation of the nation's future teachers and are forming new partnerships in the process.

In the spring of 1996, the Division of Undergraduate Education sponsored two meetings that addressed these issues: a meeting of state school officials, teachers and Deans of Education and of Arts and Sciences convened by the **Council of Chief State School Officers (CCSSO)**; and a meeting of Deans of Arts and Sciences and Deans of Education convened by the **American Association for the Advancement of Science (AAAS)**.

• CCSSO Symposium

The release of the **National Science Education Standards** poses an interesting challenge to the Chief State School Officers as they contemplate requirements for teacher certification and licensure, and to SME&T departments as they decide on courses and programs for teacher preparation in these subjects. To discuss these issues, the Council of Chief State School Officers held the *Symposium on Improving Teacher Preparation and Credentialing Consistent with the National Science Education Standards* on February 4-6, 1996, at the **National Academy of Sciences**.

Supported by NSF and the **National Research Council**, the meeting brought together delegates from 40 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands and one foreign country (Israel) to discuss the issues and exchange ideas about how the various states were planning to meet these challenges.

The symposium provided one of the first opportunities for arts and science deans to discuss the implications for teacher preparation programs posed by the new initiatives in K-12 science education.

For more information on the Council of Chief State School Officers Conference, contact **Rolf Blank**, CCSSO, One Massachusetts Avenue, NW, Suite 700 Washington, DC 20001

• AAAS Meeting

In March, 1996, more than 120 college and university deans of science and education met to discuss the preparation of K-12 mathematics and science teachers. Organized by the American Association for the Advancement of Science with the support of NSF, the forum allowed participants to exchange information and discuss issues such as the "cultural gulf" between K-12 and higher education, awareness of scholarly research on pedagogy, and ways to enhance communication between schools of SME&T and those of education.

To continue the discussion inspired by the meeting, a workbook for policy and program information to encourage collaboration between arts, science, and education is now being prepared by the AAAS.

For more information on the AAAS Deans Conference, contact **Mary Beth Lennon**, AAAS/EHR, 1200 New York Avenue NW Washington, DC 20005

Meetings and Workshops

Analytical Sciences Address Curricular Reform

The NSF Division of Undergraduate Education and Division of Chemistry are jointly funding two workshops to address the education and training of those who enter the workforce in areas defined broadly as "analytical sciences."

In addition to chemistry, analytical science impacts many disciplines, including materials science, biology, and the earth sciences where knowledge of chemical composition is essential. Current developments in science and technology are providing powerful analytical techniques to meet an increasing demand for information. Measurement, the heart of analytical science, is a systemic component of all fields in science and engineering.

Twenty-five to 30 workshop participants from academic institutions, industry, and government representing the disciplines and communities impacted by analytical science will discuss current and future needs. They will recommend ways to expand and improve undergraduate education in analytical science across undergraduate science, engineering, and technology curricula.

The first workshop will be held at the Xerox Document University, Leesburg, VA, October 28-30, 1996. The second workshop will be held in the spring of 1997. Two reports will be produced by this project: the first report will be written as an Executive Summary describing the content and outcomes of the first workshop; the second report will provide a more detailed summary of background information, discussions, and recommendations arising from the workshops. These reports will be distributed to affected communities and will contribute to "shaping the future" of education in science and engineering.

The results of the first workshop will be presented in a session at the Pittsburgh Conference on Analytical Chemistry (PCAC) in Atlanta, GA (March 1997) and the final report will be the subject of a symposium held at the PCAC conference in 1998. The two reports will each serve as an important guide to science and engineering education in the important area of analytical science.

— *Frank Settle*





Publications

Recent NSF Publications on Undergraduate Education

The Foundation provides awards for research in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and preparation of the results for publication. The Foundation, therefore, does not assume responsibility for the research findings or their interpretation.

The Foundation welcomes proposals from all qualified scientists and engineers and strongly encourages women, minorities, and persons with disabilities to compete fully in any of the research related programs described here. In accordance with federal statutes, regulations, and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving financial assistance from the National Science Foundation.

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF projects. See the program announcement or contact the program coordinator at (703) 306-1636.

The National Science Foundation has TDD (Telephonic Device for the Deaf) capability, which enables individuals with hearing impairment to communicate with the Foundation about NSF programs, employment, or general information. To access NSF TDD dial (703) 306-0090; for FIRS, 1-800-877-8339.

The following NSF publications have been released since the 1995 *DUE News* (NSF 95-149):

- NSF 96-10 *Undergraduate Education Program Announcement and Guidelines*
- NSF 96-54 *Advanced Technological Education Program: 1995 Awards and Activities*
- NSF 96-68 *Awards for Undergraduate Course and Curriculum Development FY 1995*
- NSF 96-74 *Institution-Wide Reform of Undergraduate Education in Science, Mathematics, Engineering, and Technology*
- NSF 96-77 *Directory of NSF-Supported Undergraduate Faculty Enhancement Projects*
- NSF 96-79 *Research in Undergraduate Institutions*
- NSF 96-82 *Awards for Teacher Preparation and NSF Collaboratives for Excellence in Teacher Preparation FY 1995*
- NSF 96-83 *Activities in Support of Two-Year College Science, Mathematics, Engineering, and Technology Education*
- NSF 96-102 *Research Experiences for Undergraduates*
- NSF 96-116 *Collaborative Research at Undergraduate Institutions*
- NSF 96-126 *EHR Synergy (July, 1996) Reforming Undergraduate Education*
- NSF 96-139 *Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology*
- NSF 96-141 *Executive Summary of Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology*
- NSF 96-146 *Teacher Preparation and NSF Collaboratives for Excellence in Teacher Preparation, FY 96 Awards*

If you would like to receive a printed copy of any of these documents, contact the **DUE Information Center** at (703) 306-1666, or e-mail to undergrad@nsf.gov. Written requests for information and materials can be sent to:

**National Science Foundation Division of Undergraduate Education
4201 Wilson Blvd., Room 835 • Arlington, VA • 22230**

Electronic Access to NSF Publications

A variety of methods are available:

- **World Wide Web (Mosaic/Netscape).** The URL for the NSF home page is <http://www.nsf.gov>
- **Internet Gopher.** Point your client to host stis.nsf.gov, port 70.
- **Anonymous FTP.** Host is stis.nsf.gov.
- **E-mail STIS Index.** Send ONLY the command "get index" in a message to stisserve@nsf.gov.
- **Remote log-in to Science and Technology Information (STIS).** Dial 703-306-0212, choose 1200, 2400, or 9600 baud; settings 7 E-1.

More Information on Electronic Access. To obtain an electronic version of the NSF flyer, "Getting NSF Information and Publications," send an e-mail message to stisserve@nsf.gov and include ONLY the command: `get nsf9564.txt`. For a paper copy of the flyer, call 703-306-1130 (Telephonic Device for the Deaf call 703-306-0090) and request document NSF 95-64.

DUE Program Closing Dates

Program	Closing Date
Advanced Technological Education (ATE)	
Preliminary proposals	April 29, 1997
Formal proposals	December 10, 1996 October 21, 1997
NSF Collaboratives for Excellence in Teacher Preparation (CETP)	
Preliminary proposals	April 1, 1997
Formal proposals	September 15, 1997
Course and Curriculum Development (CCD)	June 9, 1997
Institution-Wide Reform of Undergraduate Education (CCD-IR) [TENTATIVE]	
Letters of Intent	August 1, 1997
Formal proposals	September 15, 1997
Instrumentation and Laboratory Improvement (ILI)	
Instrumentation Projects (ILI-IP)	November 15, 1996 November 14, 1997
Undergraduate Faculty Enhancement (UFE)	June 9, 1997

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